Worksheet 2 Simplifying Boolean expressions

Task 1

1. X, Y and Z are Boolean variables which can be either TRUE or FALSE, represented by 1 and 0.

   Complete the following “rules” of Boolean algebra:

   General rules

   1. X ^ 0 =

   2. X ^ 1 =

   3. X ^ X =

   4. X ¬X =

   5. X ˅ 0 =

   6. X ˅ 1 =

   7. X ˅ X =

   8. X ˅ ¬X =

   9. ¬X =

   Commutative rule

   10. X ^ Y =

   11. X ˅ Y =

   Associative rule

   12. X ^ (Y ^ Z) =

   13. X ˅ (Y ˅ Z) =

   Distributive rule

   14. X ^ (Y ˅ Z) =

   15. (X ˅ Y) ^ (W ˅ Z) =

   Absorption rules

   16. X ˅ (X ^ Y) =

   17. X ^ (X ˅ Y) =

2. Write down de Morgan's first and second laws:

3. Use de Morgan's laws and the rules of Boolean algebra to simplify the following expressions, stating which rule you use at each step.

   (a) X ∧ Y ∨ X ∧ (Y ∨ Z)

   (b) (X ∨ Y) ∧ (¬X ∨ ¬Y)

   (c) $X(X\,Y)$

   (d) (X Y) (X Z)

4. Complete the truth table to show that $A\,A\,B = A\,B$

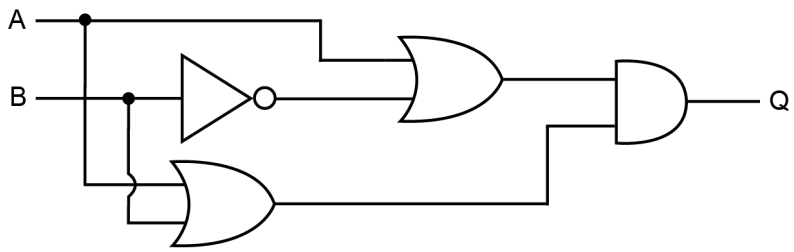
A	B	¬A	¬A ∧ B	A ∨ ¬A ∧ B	A ∨ B
0	0				
0	1				
1	0				
1	1				

Task 2

5. Simplify the expression A B A (B C)

Draw a logic circuit representing the simplified expression, using only 2 gates.

6. (a) Write the Boolean expression representing the logic circuit below.



(b) Complete the truth table to prove the Absorption rules:

X ˅ (X ˄ Y) = X

X ˄ (X ˅ Y) = X

X	Y	(X ˄ Y)	(X ˅ Y)	X ˅ (X ˄ Y)	X ˄ (X ˅ Y)
0	0				
0	1				
1	0				
1	1				

(c) Simplify the expression.

A A A B ˅ A ¬B ˅ B ¬B (Tip: Use the Absorption rule)

(d) With reference to the above example, explain why de Morgan's Laws and the rules of Boolean algebra have a huge commercial significance in the manufacture of computers.